Endiandra wongawallanensis L.Weber (Lauraceae), a new species from south-east Queensland allied to *E. floydii* B.Hyland

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Summary

Weber, L.C. & Forster, P.I. (2021). *Endiandra wongawallanensis* L.Weber (Lauraceae), a new species from south-east Queensland allied to *E. floydii* B.Hyland. ***Austrobaileya* 11: 155–169**. Analysis of morphological variation in plants previously classified as *Endiandra floydii* B.Hyland has revealed that two allopatric taxa are present. *Endiandra floydii* has a more restricted distribution than previously given and now appears to be only present in north-east New South Wales. The Queensland plants differ in a range of both vegetative and reproductive characters and are described here as the new species *E. wongawallanensis* L.Weber. It is endemic to a small area south of Beenleigh and north of Tallebudgera Creek. The new species is described with notes on distribution, habitat, dispersal ecology and conservation status. The biogeographic context for both species and the areas they occur in is discussed.

Key Words: Lauraceae; *Endiandra*; *Endiandra floydii*; *Endiandra wongawallanensis*; New South Wales flora; Queensland flora; new species; conservation status; biogeography; large fleshy fruit dispersal; refugia

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Introduction

Endiandra R.Br. (Lauraceae) comprises *c*. 100 species occurring in Asia, Malesia, Australia and the Pacific Islands with 39 species (33 or 34 species endemic) in Australia (Hyland 1989; Le Cussan & Hyland 2007; Gray 2020). *Endiandra* has been grouped with *Beilschmiedia* Nees based on molecular analyses (Rohwer & Rudolph 2005; Rohwer *et al*. 2014; van der Merwe *et al*. 2016); these two genera differ mainly in the orientation of the flower anther valves (Hyland 1989; Le Cussan & Hyland 2007). The recent study by Song *et al.* (2019) based on increased taxon sampling inferred a closer relationship between species of *Beilschmiedia* and *Syndiclis* Hook.f., with *Endiandra* resolved as sister to that group.

Endiandra floydii B.Hyland was described from a type collection made in 1985 at Tomewin, New South Wales (NSW), a location very close to the Queensland (Qld) border (Hyland 1989). The species was named after the botanist Alex Floyd who recognised this species as being undescribed, based on his collections at Upper Crystal Creek, NSW in 1977. The first collection of the species appears to have been by Clark, Pickard and Coveny in 1969 from Brunswick Heads in NSW.

Similar plants to *Endiandra floydii* were first collected by Janet Hauser in the Pimpama area of south-east Qld in 1986. These and nearby collections from south-east Qld were later identified as *E. floydii* (Barry & Thomas 1994; Jessup 1994, 1997, 2002, 2020), although the initial determinations were based on vegetative specimens and not subsequently queried. The lack of flowering and fruiting specimens from these Queensland locations may have resulted in their distinctiveness being previously overlooked.

In 2017, one of the authors (LW) being very familiar with *Endiandra floydii* from NSW, observed that specimens of "*E. floydii*" at Maudsland and Wongawallan in Qld had significantly different bark and leaf morphology from NSW plants and grew in drier types of rainforest with a different

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floristic composition. Whilst immature or rotting fruit material had been observed, no flowering material was available until recently for this possible new taxon. In 2020, Mr Reece Taverner was undertaking bush regeneration at Maudsland and sent photographs of flowers to LW who recognised a different floral morphology and flowering time from *E. floydii* in NSW. In October 2020 flowering material was observed at Maudsland, Mudgeeraba and Wongawallan in south-east Qld. This material presented different floral morphology to *E. floydii* from NSW and together with the vegetative differences confirmed the identity of a separate unnamed species.

The new species *Endiandra wongawallanensis* L.Weber, is described in this paper. It is endemic to south-east Queensland, in a small geographic area north of Tallebudgera Creek. This distribution is further discussed below in relation to its biogeographical context.

Materials and methods

This paper is based on specimens at the Queensland Herbarium (BRI) that were examined under a binocular dissecting microscope (Olympus Corporation Japan) and observations of plants in habitat. Leaves, fruit and flowers were measured with hand calipers. Field observations were carried out in Qld at all known sites for *E. floydii s.l.* (described in this paper as *E. wongawallanensis*) and in NSW for *E. floydii s.s.* at Brunswick Heads, Couchy Creek and Tomewin.

Online images of the type collection of *Endiandra floydii* were viewed on JSTOR Global Plants.

A comparison of key diagnostic features of both species is provided in **Table 1** with a species key also included to enable recognition in habitat, regenerative plantings or cultivation.

Taxonomy

Key to distinguish *Endiandra floydii* and *E. wongawallanensis*

1 Bark thick, up to 10 mm deep, patterned, corky fissured, often tessellated. Leaf lamina with midvein raised above in upper half towards apex; lateral veins 9–12 per side; domatia common, > two on some leaves, 1.5–3 mm long, raised above with an aperture below. Flowers in racemes 1–4 cm long. Corolla lime green to creamy yellow; tepals six or rarely eight, ovate to obovate with rounded apex, uneven in size with three *c.* 2 mm long and three *c.* 3 mm long alternating in the same flower, curved concave with edges curling in towards middle of the flower and flower not very widely opening, tips thickened and fleshy, > 1 mm thick at apex; glands 2-angled on the base, staminodes minute, *c.* 0.1 mm. North of Tallebudgera Creek in Qld . . . . **Endiandra wongawallanensis**

1. Bark thin, less than 5 mm deep or flat, pale, with slightly fissured corky ridges or smooth with raised lines and lenticels. Leaf lamina with midvein sunken in upper half towards apex; lateral veins 12–16 per side; domatia absent or if present than minute, < two and < 1 mm long. Flowers in racemes 4–10 cm long. Corolla pale green sometimes with red tinges to wholly dull red; tepals six, ovate to rhomboid with slightly pointed broad apex almost equal in size and < 0.5 mm difference from smallest and largest tepal in the same flower; flowers widely opening, sometimes flat or > 180° with tepals closer to flower stem than stamens, tips thin, not thickened < 1 mm thick at apex; glands with a rounded base or with two small corners of > 130°, staminodes three, *c.* 0.25 mm, on top of glands between larger stamens. South of Tomewin in NSW . . . . **Endiandra floydii**

Endiandra wongawallanensis L.Weber **sp. nov.**

Similar to *E. floydii* B.Hyland but differing in adult trees often being taller than 15 m and with the bark on mature trees being corky, deeply fissured and tessellated vs smooth or shallowly fissured or cracked on that species. Some leaves commonly have multiple pit domatia to 3 mm diameter that are raised above and form a deep pocket below vs occasional minute domatia (*c.* 1 mm diameter) that are not raised above on *E. floydii*. Tepals of two different sizes, three small (*c.* 2 mm long) alternating with three large (*c.* 3 mm long) rather than six of similar size (3.5–4 mm long) for *E. floydii*. Inner surface of tepals concave and thickened (*c.* 1 mm thick) vs flat (*c.* 0.5 mm thick) for *E. floydii*. Staminodes minute, *c.* 0.1 mm vs *c.* 0.25 mm in *E. floydii*. **Typus:** Queensland. Moreton District: Gold Coast City Council Park and Recreation Reserve, off Tanby Court, Mudgeeraba, 4 November 2020, *P.I. Forster PIF47068 & G. Leiper* (holo: BRI [3 sheets plus spirit]; iso: CNS, L, MEL, NSW, US *distribuendi*).

Illustrations: Harden *et al.* (2006: 137, as *E. floydii*); Leiper *et al.* (2017: 285, fruit is *E. wongawallanensis*, flowers are *E. floydii*).

Tree to 20 m (or rarely 27 m) tall, with a spreading canopy. Trunk up to 40 cm diameter at breast height, often multistemmed; base of trunk with small spur buttresses and commonly with smaller coppice shoots especially after low intensity fires. Bark fissured to tessellated, corky, moderately thick to 10 mm, pale brown to fawn. Branchlets green and smooth in leafy sections, with scattered silvery brown hairs on the growing tip; older branchlets with corky pale brown lenticels merging and forming a rough bark on the thicker branchlets. Leaves usually alternate except for occasional nearly opposite pairs on branch tips below flowers, coriaceous, flexible; petioles 6–9 mm long, slightly thickened at base with scattered hairs. Lamina elliptic to ovate, 5–12 cm long, 1.5–3.5 cm broad (up to 14.7 cm and 4.7 cm and undulate at Bonogin), the broadest point usually being closer to the petiole or occasionally at the middle and then gradually tapering towards apex, length to width ratio average 3.2; base cuneate to occasionally obtuse; apex long-acuminate and blunt tipped; juvenile coppice or seedling foliage is broader with base obtuse and apex short acuminate; glossy, mid-green above and paler below, glabrous; fresh leaves with midvein curving down and the sides of the lamina curved up; domatia comprising medium sized pits in lateral vein angles, forming a raised lump above and with a small hole on the underside, 1.5–3 mm long and obvious on broader leaf laminae; midvein raised above and below, straight or slightly zigzagged in leaves with domatia, yellowish white; main lateral veins 5–10 per side becoming indistinct at apex; interlateral net venation forming a closely raised network above and below. New growth pale green and old leaves turning yellowish. Flowers in axillary panicles, 1–4 cm long; subtended by persistent bracts (paired bracts below each flower and a single bract subtending inflorescence branches), present at anthesis, 1–2 mm long, with pale brown hairs. Flower pedicels *c.* 2 mm long; buds globose, lime green with whitish waxy raised, elongated lumps. Flowers opening lime green then aging to creamy pale yellow, not strongly scented. Perianth segments (tepals) 6 or rarely 8, obovate to concave-ovate on the inside and thickened to *c.* 1.5 mm near apex; larger tepals (usually 3) are *c.* 3 mm long and 3 mm wide, smaller tepals (usually 3) are *c.* 2 × 2 mm, similar coloured from base to tip. Glands below stamens forming a tripartite ring in the centre of the flower and raised < 0.5 mm above the tepals; each gland basally 2-angled. Stamens 3 or rarely 4; pollen sacs rhomboidal or triangular with rounded corners *c.* 0.6 × 0.4 mm, green to cream. Staminodes the same number as stamens, minute and *c.* 0.1 mm long, on top of glands between stamens. Fruit: pedicel 2–3 cm long, thickened; drupe globose, 5–7 cm long, turning red then black with a thin glaucous waxy bloom, textured with numerous, closely spaced raised lumps *c.* 0.2 mm high on skin when ripe; immature fruit shiny, globular green and resembling a passionfruit, also with a finely textured surface; calyx persistent on top of fruit, fleshy sometimes remaining green on ripe fruit with 3 larger and 3 smaller sized tepals alternating around the pedicel joint; exocarp fleshy, 3–10 mm thick, creamy green, resinous; ripe fruit smell somewhat of ammonia and avocado when cut, older fallen fruit strongly scented. Seed globular to ovate, 45–57 mm long, apex rounded or with a small protrusion or slight depression, base not raised; endocarp light brown with a darker brown network of both broad and fine, slightly raised veins. Cotyledons ivory white inside endocarp, turning creamy orange on exposure to air. **Figs. 1–10**.

***Additional specimens examined*: Queensland.** Moreton District: Upper Ormeau, Jul 2004, *Leiper s.n.* (BRI [AQ767463]); Pimpama, Jul 1986, *Hauser s.n.* (BRI [AQ440484]; Hotham Creek Road, Pimpama, Feb 1992, *Leiper s.n.* (BRI [AQ583192]); property of Miles family, Hotham Creek, Pimpama, Feb 1992, *Hauser & Leiper s.n.* (BRI [AQ540375]); Hotham Creek, Pimpama, Nov 1993, *Miles s.n.* (BRI [AQ621564]); Hotham Creek, Willowvale, Jan 1994, *Thomas & Barry s.n.* (BRI [AQ636488]); 8 km NNE of Eagle Heights, Dec 1994, *Halford Q2368* (BRI); Wongawallan off Lanes Road, Sep 2003, *Leiper s.n.* (BRI [AQ762862]); Hotham Creek, Ruffles Road, Jun 2012, *Forster PIF38774, Leiper & Miles* (BRI); *ibid*, Oct 2020 *Leiper s.n.* (BRI, CNS, MEL, NSW); Adams property, Guanaba, Aug 1997, *Hauser s.n.* (BRI [AQ655823]); Maudsland, Jul 2003, *McDonald s.n.* (BRI [AQ777484]); Saltwater Creek, Pacific Pines Estate near Maudsland, Aug 2003, *McDonald s.n.* (BRI [AQ778851]); Finnin Court, Maudsland, Jan 2018, *White s.n.* (BRI [AQ970833]); Clover Hill SE of Bonogin Road, Mudgeeraba, Sep 1997, *Hauser s.n.* (BRI [AQ655822]); Clover Hill Farm, Mudgeeraba, Jul 2021, *Forster PIF47488 & PIF47497, Jinks & Leiper* (BRI).

***Distribution and habitat*:** *Endiandra wongawallanensis* is endemic to south-east Qld where it is known from north of Tallebudgera Creek and south of Beenleigh, with most locations in the Darlington Range (Ormeau, Wongawallan) east and north of Mt Tamborine and an outlying southern location at Clover Hill, Bonogin near Mudgeeraba. The altitude range is 10 to 350 m. The known distribution is only 15 km north to south and 7.5 km east to west or 113 km^2.

Endiandra wongawallanensis occurs in subtropical rainforest or on its ecotonal edges, with mean annual rainfall of 1000–1500 mm. The species occurs on both hills and valleys, composed primarily of Neranleigh Fernvale metasediment geology, often with outcropping surface rock. At the type locality, the predominant metasediments are intermixed in creek lines with limited andesitic flows; however, *E. wongawallanensis* is invariably on alluvial flanges away from these flows. By contrast at the Clover Hill locality, the metasediments are enriched by shallow and variable overlying flows of basalt. *E. wongawallanensis* grows in variable species assemblages with canopy dominant species such as *Acacia bakeri* Maiden, *Araucaria cunninghamii* Mudie, *Dissiliaria baloghioides* F.Muell. ex Baill., *Eucalyptus grandis* W.Hill, *Euroschinus falcatus* Hook.f. and *Flindersia schottiana* F.Muell. Other laurels also growing in association include *Cryptocarya glaucescens* R.Br., *C. microneura* Meisn., *C. triplinervis* var. *pubens* B.Hyland and *Endiandra muelleri* subsp. *bracteata* B.Hyland. Listed threatened flora that may co-occur or occur close by are *Baloghia marmorata* C.T.White, *Brachychiton* sp. (Ormeau L.H.Bird AQ435851), *Cassia marksiana* (F.M.Bailey) Domin, *Macadamia integrifolia* Maiden & Betche and *Randia moorei* F.Muell.

Endiandra wongawallanensis is particularly common on the upslope ecotonal margins of rainforest patches adjacent to or on margins of dry sclerophyll forest dominated by variable mixtures of *Corymbia intermedia* (R.T.Baker) K.D.Hill & L.A.S.Johnson, *Eucalyptus acmenoides* Schauer, *E. pilularis* Sm., *E. propinqua* H.Deane & Maiden, *E. siderophloia* Benth., *Lophostemon confertus* (R.Br.) Peter G.Wilson & J.T.Waterh. and *Syncarpia glomulifera* (Sm.) Nied. subsp. *glomulifera.* These ecotones suffer repeated fire, and the thick corky bark of the *Endiandra* stems may have been selected as an adaptation to withstand fire. J. Searle recorded that a fire burned some individuals of *E. wongawallanensis* (as *E. floydii*), killing the main trunks; however, these individuals produced new sucker shoots from the bases (DEC 2004).

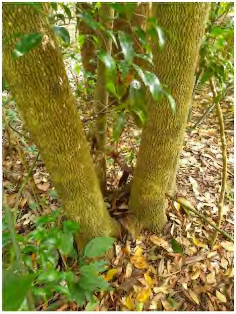

Fig. 1. ***Endiandra wongawallanensis***, habit of adult stems (Tanby Court, Mudgeeraba). Photo: L. Weber.

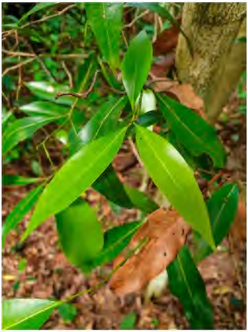

Fig. 3. ***Endiandra wongawallanensis*** with new foliage growth (Tanby Court, Mudgeeraba, Qld). Photo: L. Weber.

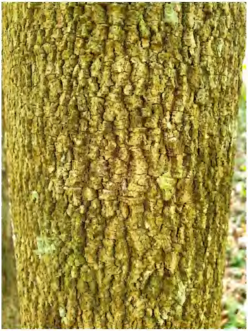

Fig. 2. ***Endiandra wongawallanensis*** with thick, corky, fissured and tessellated bark on large trees (Tanby Court, Mudgeeraba, Qld). Photo: L. Weber.

Fig. 4. Leaf underside of ***Endiandra wongawallanensis*** showing hollow pit domatia (Lanes Road, Wongawallan). Photo: L. Weber.

Fig. 5. Flowering racemes of ***Endiandra wongawallanensis*** (left) (Tanby Court, Mudgeeraba) and ***E. floydii*** (right) (cultivated Murwillumbah). Photos: L.Weber.

Fig. 6. Flowers of ***Endiandra wongawallanensis*** showing evenly green coloured tepals, chocolate brown glands, green stamens and yellow anthers. Staminodes are minute and hard to see. (Tanby Court, Mudgeeraba). Photo: L. Weber.

Fig. 7. Globose fruit of ***Endiandra wongawallanensis*** (Maudsland, Qld). Photo: L. Weber.

Fig. 8. ***Endiandra wongawallanensis***, ripe fruit (*c.* 5.7 cm ×5.7 cm) showing radial linear ridges and waxy grey bloom (Tanby Court, Mudgeeraba). Photo: L. Weber.

Fig. 10. ***Endiandra wongawallanensis***, seed endocarp (Tanby Court, Mudgeeraba). Photo: L. Weber.

Fig. 9. ***Endiandra wongawallanensis***, transverse section of fruit, seed and cotyledons (Maudsland, Qld). Photo: L. Weber.

Endiandra wongawallanensis is absent from similar subtropical rainforest habitats on the same geological substrates at Bahr's Scrub, just to the north of the known range. The Albert River may have been a biogeographic barrier that prevented this species from reaching these apparently suitable habitats. No subpopulations have been located between Mudgeeraba Town and Nerang, but some areas of suitable habitat may have been lost when historical clearing occurred.

***Phenology*:** Flowering period September to November. Fruiting period February to March.

***Notes*:** A full comparison of morphological features between *Endiandra floydii* and *E. wongawallanensis* is provided in **Table 1**. When examining material it is important that for some characters (e.g. domatia), more than single leaves are studied.

Endiandra wongawallanensis trees superficially resemble *Cryptocarya microneura* in many features including leaf morphology (the drawn-out blunt leaf apex, orientation, colour, midvein zig zags, midvein colour) and bark type. The habitat on the margins of sclerophyll forest is also occupied by *C. microneura*. *Endiandra wongawallanensis* has larger flowers and fruit than *C. microneura* and when not fertile in the field, is distinguished by its glossier leaves with a sparser areolate reticulate intralateral venation and lack of a fine waxy bloom on the leaf undersides.

The outlying southern subpopulation of *Endiandra wongawallanensis* at Clover Hill has a few minor morphological differences to the northern subpopulations, although these are not always consistent when examining a range of material. The leaves are slightly larger with sometimes undulate margins and less domatia and the bark is slightly thinner but still corky and fissured. This variation is not consistent as some trees at this location have smaller leaves and thicker bark similar to the subpopulations further north. Flower buds appear to have a flat, pale waxy marbled pattern under the surface, similar to *E. floydii*. This is in comparison to the slightly raised, waxy ridges present in the flower buds of the northern subpopulations of *E. wongawallanensis.*

Table 1. Morphological comparison of *Endiandra floydii* and *E. wongawallanensis*

Character	*Endiandra floydii*	*Endiandra wongawallanensis*
Bark	thin, less than 5 mm deep or ± flat, white to fawn, with very fine to thin fissures and striations or corky ridges; similar in larger trees	thick, up to 10 mm deep, corky with vertical fissures or tessellated with rectangular corky sections and corky lumps, pale cream; thicker and lumpier in older specimens
New growth flush colour	pale salmon pink, aging to pale green	pale green
Lamina shape	elliptic to lanceolate, often oblanceolate	elliptic to ovate
Leaf apices	acute to short acuminate	long acuminate
Leaf bases	cuneate, sometimes slightly asymmetric	cuneate to obtuse, sometimes slightly asymmetric
Leaf lamina	pale yellow-green to mid grey-green and glossy above, paler and glossy below	dark green to mid-green and moderately glossy above, paler and moderately glossy below
Broadest part of leaf lamina	near middle with some below and often above middle	usually ⅓ of distance from base to the mid-point

Domatia	absent or occasionally weakly developed, thickening in some vein angles, very rarely 1 or 2 tiny hollow pits below, but not notably raised above	present as hollow pits on some leaves, forming a pocket in the lamina in vein angles, raised above and hollow below, more than 2 well developed domatia per leaf where present
Midvein	always straight to slightly curved left or right; obviously raised below from base to apex; raised above only near base and sunken for most of leaf length towards apex	zig zagged between domatia when present otherwise almost straight to slightly curved; raised below for most of leaf length but not obviously raised at apex below; raised on upper surface for most of the leaf length
Lateral venation	moderately curved, 12–16 per side	strongly curved, 9–12 per side
Intralateral venation	indistinct above, distinct below on fresh leaves, more distinct in dried material	distinct above and below on fresh leaves, more distinct in dried material
Inflorescence panicle	often erect to slightly pendulous, 4–10 cm long	pendulous, 1–4 cm long
Flower buds	globose to obovoid, often with obtuse point formed by tepal tips, green to dull red; surface with flat, waxy patterned paler marbling	obovoid, lacking an obtuse point formed by tepal tips, lime green or cream yellow; surface with raised, waxy elongated lumps (not so in Bonogin subpopulation)
Tepal shape and thickness	inner surface (young flowers in particular) almost flat to slightly concave; almost even in size; laminae flattened and thin, *c.* 0.5 mm thick	inner surface concave, outer convex; differing significantly in size with 3 larger and 3 smaller tepals (rarely 4 large & 4 small) in alternating sequence; laminae thickened towards tips, *c.* 2 mm thick
Tepal colour and orientation	pale green to red; widely opening flat on maturity often even opening backwards beyond 90° towards petiole	dark green, ageing to pale creamy yellow; opening to less than or equal to 90°
Flower glands	3; green to red on newly opened flowers, darker on older flowers; raised *c.* 1.5 mm above tepals	3 rarely 4; chocolate brown on newly opened flowers, red brown on older flowers; raised less than 0.5 mm above tepals
Stamens	cream and sometimes pale pink in centre of anther sacs	pale green to cream
Staminodes	3; flattened, obvious on top of glands between stamens, *c.* 0.25 mm long	3 or 4; minute, *c.* 0.1 mm long
Style	cream to pale pink, *c.* 0.6 mm long	pale green, *c.* 0.5 mm long
Ripe fruit	ovoid, obovoid to pyriform, 6–10 cm long; smooth with a blue grey waxy bloom wearing off to reveal shiny black skin; persistent floral parts often drying brown on ripe fruit	globose, 5.5–6.5 cm long; with micro texture dimples, matt to slightly shiny black, sometimes with thick waxy bloom; sometimes with persistent, green fleshy floral parts
Cotyledons	pale yellowish-pink, oxidizing to dark orange brown or turning green on germinating seeds	white, turning pale creamy orange on exposure to air

Etymology: The specific epithet refers to the locality where this species was first recognised as being distinct, namely Wongawallan. This word is also applied to a local mountain. Wongawallan is believed to derive from two Yugambeh Aboriginal words wonga (pigeon) and walla (water) (GCCC 2021).

Conservation status: *Endiandra floydii s.l.* is currently listed as **Endangered** under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999, the NSW *Biodiversity Conservation Act* 2016 and QLD *Nature Conservation Act* 1992.

The recognition of *Endiandra wongawallanensis* as a distinct species from *E. floydii* has significant implications for the conservation of these species. Material of *Endiandra floydii* is widespread in cultivation (generally of unknown origin) and has been used in revegetation plantings in Queensland within the range of *E. wongawallanensis* or to augment subpopulations of that species.

The recognition of two separate species increases the conservation concerns for both, especially for *Endiandra wongawallanensis.* The newly described species has a known distribution in two subpopulation centres. The northern centre is *c.* 15 km north to south and only 10 km east to west, whereas the isolated southern subpopulation at Clover Hill, Mudgeeraba is less than 4 km². This tiny distributional range is one of the smallest for any laurel in Australia. The habitat of *E. wongawallanensis* has been extensively cleared for agriculture over the past century and has recently been subjected to extensive suburban development and growth on the perimeters of the Gold Coast. Fortunately, the Gold Coast City Council has had the foresight to recently purchase land containing dry rainforest supporting a number of subpopulations including Willow Vale Scrub, so this subpopulation at least is secure; however, weed invasion of forest edges and inappropriate fire regimes remain a threat. Some of the other subpopulations are still threatened by suburban development and adjacent quarrying activity.

With an estimated *c.* 470 known adult plants across all subpopulations and fewer than 50 mature individuals in any one of the northern subpopulations (**Table 2**), *Endiandra wongawallanensis* is most likely to meet the IUCN red list criteria for **Endangered**.

Extent of occurrence (EOO) is estimated at 65 km² for the Ormeau–Wongawallan–Maudsland subpopulations and 3.5 km² for the Mudgeeraba subpopulation. Area of occupancy (AOO) is much smaller, approximately 20 km² based on the number of occupied standard 4 km² grids. With an actual EOO of less than 100 km², *E. wongawallanensis* qualifies for **Critically Endangered** under Red List criterion B1a,b(i-v). However, when all subpopulations are included in an analysis, the EOO increases beyond 100 km² despite the intervening area between the two subpopulation centres not having the species present. Based on the Extent of Occurrence, Area of Occupancy, and an estimated 470 mature individuals, it easily qualifies for **Endangered** based on criteria B1a,b(i-v); 2a,b(i-v); C1 (IUCN 2019). A formal nomination for listing under the Qld *Nature Conservation Act* 1992 will be made elsewhere.

Endiandra wongawallanensis is not known from any formal conservation reserves (National Parks, Nature Reserves and Nature Refuges) (DOE 2021). The largest subpopulation at Clover Hill is on private or Gold Coast City Council land on multiple titles, with the largest group of trees (*c.* 1000, although not all are adult) on the former (**Table 2**); both are currently being managed for conservation purposes. The second largest subpopulation at Lanes Road, Wongawallan (Willowvale Scrub) is within a property managed for conservation by the Gold Coast City Council and the species is present within several other council reserves (**Table 2**).

Dispersal ecology and its significance for *Endiandra floydii* and *E. wongawallanensis*

In the rainforests of the north Queensland Wet Tropics bioregion, laurel fruits fall into two main size classes with dispersal by differing animals. Species with fruits up to 3 cm long are dispersed predominantly by pigeons and fruit bats. Larger fruits (generally > 5 cm diameter) are dispersed by southern cassowaries (*Casuarius casuarius* (Linnaeus, 1758)) (Cooper & Cooper 2004) and scatter hoarded by musky rat kangaroos (*Hypsiprymnodon moschatus* Ramsey, 1876) and giant white-tailed rats (*Uromys caudimaculatus* (Krefft, 1867)) (Dennis 2002, 2003). In subtropical Australian rainforests the same two size classes are present in laurel fruit; however, cassowaries, musky rat kangaroos and giant white-tailed rats are not currently present. A fossil dwarf cassowary has been putatively recovered from Pleistocene deposits in NSW (Miller 1962), although this provenance has been disputed by some authors (Rich *et al*. 1988). Fossils attributed to, or with similarities to *Hypsiprymnodon* are known from South Australia and Victoria (Bates *et al.* 2014). Large-fruited laurels of the subtropics may have been dispersed by these or similar species, or other extinct megafauna such as the herbivorous giant horned land turtle *Ninjemys oweni* (Woodward, 1888) that was described from a Pleistocene fossil deposit on the Darling Downs of Qld (Sterli 2015). The extinction of megafauna from subtropical eastern Australia is now thought to be relatively recent dating to the Quaternary, *c*. 280,000 years ago (Hocknull *et al*. 2007). The case of *Endiandra compressa* C.T.White (another laurel with large fruit) is the most convincing in this regard, as this species is known to be consumed by cassowaries in the northern tropical part of its distribution, but is rare and restricted to stream banks in the subtropical zone where this bird is absent.

Plants with large fruit that are no longer effectively dispersed are considered an evolutionary legacy (Galetti *et al*. 2018), as their fruits were adapted for dispersal by a now extinct megafauna (Johnson 2009; Weber 2013; Rossetto *et al*. 2015). Both *Endiandra floydii* and *E. wongawallanensis* do not appear to be effectively dispersed, with the large fruits accumulating near to the parent trees. This clumping of individuals does not appear to be particularly associated with lack of habitat and is most likely an example of dispersal limited distribution (Primack & Miao 1992; Rossetto *et al*. 2008). This apparent lack of dispersal, along with habitat fragmentation are the most likely contributors to their rarity within the known distribution ranges. This is based on their extant distribution in mesic refugia in the subtropics (Weber *et al*. 2014), as they are replaced by other large fruited *Endiandra* species in the tropics of Queensland, thus not supporting the contention of Bunney *et al*. (2019) that such species are merely a tropical phenomenon.

Biogeographic history in relation to *Endiandra floydii* and *E. wongawallanensis*

The Border Ranges Refugium (BBR) associated with the Mt Warning volcanic caldera is one of the most significant refugia for rainforest on the Australian continent given its geographic location in the subtropics. Palaeoclimatic models predict rainforest habitat between Mt Tamborine and Ballina to have been highly stable for the past 120,000 years (Weber *et al.* 2014). Numerous rainforest plant species including *E. floydii* are endemic to this refugium.

North of the BBR rainfall rapidly decreases, with the rainforest communities demonstrating a concomitant decrease in species richness together with an increase in sclerophylly and deciduousness. This is further complicated by complex local variations in geology ranging from volcanics (andesites, basalts, metabasalts, rhyolites) to metasediments (chert amongst others). These drier rainforests on the northern margin of the BRR, especially north and east of Mt Tamborine (Northern Darlington Range) are interesting from a biogeographic standpoint in this respect. They contain a mix of taxa ranging from those more common in wetter (notophyll to mesophyll) communities to those prevalent in drier (predominantly microphyll) communities. They contain a small number of known endemic taxa (e.g. *Brachychiton* sp. (Ormeau L.H.Bird AQ435851), *Coleus habrophyllus* (P.I.Forst.) P.I.Forst., an undescribed species of *Backhousia*), with *Endiandra wongawallanensi*s adding to this list of narrow-range endemics from this restricted area. The area also encompasses the northern or southern limits for numerous other rainforest plant species (Forster *et al*. 1991).

Past climate change in the area under discussion would have caused habitat fluctuations for probably over 1 million years, as the rainforests expanded and contracted on the margins of the BBR in direct contact with the Dry Brisbane Valley Barrier (Weber *et al*. 2014). These dry rainforests may have functioned as a "semi-arid cradle" as suggested by OCBIL theory (Hopper 2009; Hopper *et al*. 2021), insomuch as they persist on ancient, weathered landscapes with low phosphorus content (i.e. the metasediments), intermixed with more recent landscapes formed from volcanic activity. These rainforests probably sheltered relict species contracting from previously wider distributions (possibly the case with *Endiandra wongawallanensis*) and perhaps facilitated the evolution and speciation of new taxa such as *Brachychiton* sp. (Ormeau L.H.Bird AQ435851) and *Coleus habrophyllus*.

Endiandra wongawallanensis and *E. floydii* are postulated to be allopatric sister taxa, with the former restricted to the drier rainforests on predominantly metasediments of the Northern Darlington Range and the latter to the wetter rainforests on metasediments and rhyolites (rarely on coastal sands) in the Border Ranges and adjacent coast. Some morphological features unique to *E. wongawallanensis* (e.g. thick corky bark) may have been selected for due to more frequent fires in its drier habitat. Despite only 20 km separating the most northern location of *E. floydii* and the most southern location of *E. wongawallanensis*, it is unlikely that recent genetic flow between the two taxa has occurred. It is also unlikely that the two taxa are still capable of interbreeding when cultivated together due to different flowering times; however, it is recommended that *E. floydii* no longer be used as a regeneration species to augment *E. wongawallanensis*. The purported inability to interbreed is further support for recognition as separate species under an evolutionary species concept (Wiley 1978).

Table 2. Numeric estimates for all known extant locations of *Endiandra wongawallanensis*

Location	Voucher at BRI	Land Tenure	Estimated Number of Adult Trees
Hotham Creek, Pimpama	*Hauser JH127*	Private	20?
Hideaway Road, Upper Ormeau	*Leiper s.n.* (AQ767464)	Private	5?
Ruffles Road, Willow Vale	*Forster PIF38774 et al.*	Private	3
Lanes Road, Wongawallan	*Leiper s.n.* (AQ762862)	Council Conservation Area	50
Crest Hill Drive, Wongawallan	unvouchered	Private	5
Wongawallan Drive, Wongawallan	unvouchered	Council Conservation Area	25
Sunvalley Court, Guanaba	*Hauser s.n.* (AQ655823)	Private	3
Caballo Road Reserve, Candy Creek, Guanaba	unvouchered	Council Conservation Area	Unknown
Northern Skies Terrace, Maudsland (Riverstone Crossing)	unvouchered	Crown Land	10
Whittington Way, Maudsland	unvouchered	Private	10
Guanaba Creek Road, Guanaba	unvouchered	Private	5
Finnin Court, Maudsland	*White s.n.* (AQ970833)	Council Conservation Area	3
Roberts Drive, Maudsland	unvouchered	Private	10
Tanby Court, Mudgeeraba	*Forster PIF47068 & Leiper*	Council Conservation Area	20
Clover Hill Farm, Mudgeeraba (D. Jinks pers. comm. July 2021)	*Forster PIF47488 et al.*	Private	*c.* 300
Total			*c.* < 470

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